NEW YORK STATE COLLEGE OF AGRICULTURE CORNELL EXTENSION BULLETIN 1055

Control of Wildlife Damage in Orchards

BY W. ROBERT EADIE

CONTENTS

Meadow Mice 3
Discouraging mice by orchard practice 4
Conducting a baiting program 5
Hand baiting 5
Machine baiting 6
Ground sprays for meadow mouse control 7
Other ways to control meadow mice 8
Pine mice 9
Special methods for pine mouse control 10
Ground sprays for pine mouse control 10
Spray after harvest 10
Use correct concentration and rate of application 11
Rabbits 11
Fencing for protection from rabbits 12
Reduce damage with repellents 13
Rosin-alcohol repellent 13
Thiram repellent mixtures 13
Nicotine sulfate repellents 14
Deer 14
Fences 14
Repellents 15
Thiram 15
ZIP 15
Other repellents 16
Applying repellents 16
Costs 16

Research conducted by Cornell University was supported in part by the New York State Conservation Department and Federal Aid in Wildlife Restoration (P-R Project W-77-R).

Cooperative Extension Service, New York State College of Agriculture at Cornell University and the U. S. Department of Agriculture cooperating. In furtherance of Acts of Congress May 8, June 30, 1914. M. C. Bond, Director of Extension, Ithaca, New York. PS–5M

Control of Wildlife Damage in Orchards

W. Robert Eadie

Several kinds of wildlife may damage orchards in New York State and create serious economic problems for fruit growers. Meadow mice live in every sod orchard and are a constant threat to the life and health of trees of all ages. Pine mice are a special problem to growers in some areas of southeastern New York. In years when they are abundant, cottontail rabbits may damage trees badly. Deer are now numerous in many agricultural areas and often harm trees by browsing or thrashing them. It is not always possible to prevent damage from these forms of wildlife, but much can be done to reduce it.

MEADOW MICE

Meadow mouse damage to orchard trees amounts to thousands of dollars annually. These mice vary greatly in numbers from year to year, and in some years may be extremely destructive unless *regular orchard practice* reduces this danger.

Trunk girdling at or near the ground surface is the most common form of injury. Sometimes girdling injury can be repaired by bridge-grafting, but tree growth always is set back severely. Meadow mice can burrow in some soils and damage roots in a way that cannot be seen or repaired and which results in weak, unhealthy trees. Luckily, root damage is less common with meadow mice than with pine mice.

Meadow mice are easily recognized as the common mice of the grasslands. Adults may measure up to seven inches in length, including a tail of less than two inches. These mice are blunt-nosed, short-eared, and blocky in form, with small eyes and short legs. The general color of the upper body is dark grayish-brown with scattered black hairs; the underparts are paler and grayer.

In dense ground cover these mice make a complex network of well-marked surface runways; when the ground cover is light and open, the runways may be less distinct or even absent. Grass cuttings and small piles of droppings may litter well-used runways. Burrows are often dug, especially in loose soils, and nests may be placed at the end of short burrows. Often nests are built on the ground surface in a clump of grass; they are well-formed balls of interwoven grass that provide good shelter in all weather.

Meadow mice are active at intervals both day and night, but seem to have peaks of activity in the early morning and late afternoon. The living area for an individual mouse may not exceed one-half acre. The usual food is grass and herbs, but during fall and winter, the cambium layer of bark may be eaten.

The potential breeding rate of meadow mice is very high. They can produce from five to 10 litters per year with an average of five young per litter. Gestation is about 21 days, and females may mate again soon after the young are born. These young grow quickly, are weaned at two or three weeks, and are ready to breed in a month or two. Thus from low spring levels, orchard mouse populations may rise quickly to dangerous fall levels.

Discouraging Mice by Orchard Practice

Orchard management can have an important bearing on mouse damage. Young orchards that are thoroughly fall-cultivated will be relatively free from mice except where borders are grassy or weedy. In older sod-orchards, repeated mowings during the growing season will remove both food and cover and expose the mice to their natural enemies. This may also lower their breeding potential. Clean fence rows or borders also help to reduce harborage.

Clearing a four- or five-foot circle at the base of the tree of vegetation in the fall has a tendency to keep mice away from the trunk (see below). Grass killers may be used instead, and this bare area made more permanent by placing an inch or two of gravel or cinders over it.

Wire guards and cleared tree bases help to reduce mouse damage.

Protect young trees by embedding cylindrical wire guards several inches deep at the tree base. These are made from quarter-inch mesh galvanized hardware cloth, 24-inches wide. Use the cut ends to form the screen into a cylinder large enough to allow for five-years' growth. The many years of protection provided by this type of guard will more than repay the investment of labor and 25 cents worth of material. Other materials that are used for this purpose are: building paper, veneer, burlap, and aluminum foil. However, none of them is so long-lasting or so satisfactory in all respects as hardware cloth.

Conducting a Baiting Program

Most commercial growers find that an annual, fall mouse-baiting program is an effective and economical way to reduce mouse damage. There are several successful ways of baiting mice but the choice of a method will depend on the size of the orchard, relative costs, and the amount of time available for the program.

Hand baiting

Hand baiting is excellent for small orchards of only a few acres, but labor and costs become excessive when it is used in large orchards. In hand baiting, a limited number of baits are placed directly in the active runways of the mice. Go through the orchard systematically, locate well-defined runways, and place four to six baits in the area around each tree. After placing a bait, push the vegetation over the spot. Common sense will dictate the efficient pattern of travel in the tree rows. Bait fence rows or orchard borders, also.

Cut-apple baits dusted lightly with zinc phosphide are most commonly used for hand baiting. The United States Fish and Wildlife Service, Division of Predator and Rodent Control, distributes a preparation for this purpose, Zinc Phosphide Rodenticide, which contains magnesium carbonate as an inert ingredient and spreading agent.

Fresh Apple and Zinc Phosphide Bait

Fresh apple cubes – 1 quart

Zinc Phosphide Rodenticide – 1 level teaspoonful (1.5 grams)

Cut apples of a firm variety into half-inch cubes without peeling or coring. Put the apple cubes in an enamel pan and sift the poison over them, stirring constantly with a paddle to insure even distribution. This will make approximately 125 baits.

If a supply of Zinc Phosphide Rodenticide is not available, apple cubes may be dusted lightly with a finely powered grade of arsenic trioxide. Although mice accept zinc phosphide more readily, arsenic is fairly effective. In freezing weather, or as an alternative bait, a teaspoonful of poisoned grain, prepared as indicated on page 6, may be placed by hand in runways.

Machine baiting

Studies have shown that meadow mice forage out from their runways and easily locate grain baits scattered thinly at random in the grass. Several methods of baiting the orchard with machines take advantage of these facts. These methods are best for large commercial orchards because labor costs are much lower, baiting may be done quickly to make best use of good weather, and workers are freed for other duties.

Machine-Distributed Bait

Coarsely cracked corn	100 pounds
Zinc phosphide (Commercial grade)	2 pounds
Vegetable oil	1 quart
Methyl Green dye	½ ounce

Work outdoors or in an open shed, and wear gloves. *Avoid breathing dust or fumes.* Mix the dye with the dry zinc phosphide, then add the oil to form a thin paste or slurry. Pour this over the corn in a large metal tub and use a hoe to mix the mass until each grain is evenly coated. A cement or tumble mixer may be used for large amounts of bait. *Anything used for mixing must be used only for that purpose or thoroughly scrubbed afterward with soap and water.*

The prepared grain bait may be placed in sacks or other containers at once, and stored in a dry place until used. The bait will keep for several months, but it should not be retained from one year to the next, because it slowly weakens.

Prepared cracked-corn bait for machine baiting may be bought from commercial sources, if growers prefer it. A zinc phosphide-oats bait for this purpose is sold by the United States Fish and Wildlife Service.

The green dye and the black color of the zinc phosphide serve to disguise the grain and to discourage wild birds from eating it. *Caution*: domestic poultry may not reject it.

Placing the bait. One way to place the cracked-corn bait is to use a hand or tractor-mounted seeding device that will handle the grain. Drop the bait in a single line on either side of the tree row in the thickest grass along the drip-line. Garden seeder units or modified corn planters may be used. Adjust them to drop eight to 10 grains per foot of row. Do not *plant* the bait. Three or four pounds of bait per acre should be enough with this method.

Another effective way to bait a large orchard is to use a tractor-mounted, whirling-disc-type fertilizer spreader. One trip on each tree row is enough for good coverage. This method may use eight or 10 pounds of bait per acre, but the expense is offset by faster baiting. Results have been excellent in many orchards.

Airplanes may be used to spread the bait quickly in large orchards. Custom-dusting airplanes with large hoppers can bait 200 or 300 acres in less than a day

by making one pass over each tree row. This method makes best use of brief periods of fair weather. Six to eight pounds of bait per acre are enough to use.

Results and costs. The numbers of mice killed by machine baiting has ranged from 70 to 100 per cent of estimated population when baiting was properly done in good weather. This equals the usual results obtained from hand baiting the orchard.

Total costs of machine baiting by these various methods range from $1.00 to $2.50 or more an acre. Hand baiting may cost more than four times as much.

Watching the weather. Bad weather has a marked effect on the success of baiting. If the grass is wet with rain or heavy dew when the bait is spread, or if heavy rain follows closely after baiting, the kill percentage drops. Water washes the poison from the bait, and because mice are less active in bad weather, fewer mice find the baits.

Watch the weather reports and try to plan on two or three days of fair weather for the baiting operation. Brief periods of light rain after baiting are not so serious as heavy rains.

Checking the results. Mouse traps are useful for checking the results of the baiting program, although they are not practical as a method of control in orchards. Growers may check their results a week or two after baiting by setting four wooden snap traps in the heavy cover under each of ten or more adjacent trees in a row. Set the traps in runways at right-angles, with the trigger in the trail. Drop a pinch of oatflakes over the trigger for bait. If more than a few mice are caught overnight, some repeat baiting may need to be done several weeks after the first baiting.

Surviving mice sometimes continue to breed in late fall and early winter. A few survivors may increase to a moderate number by mid-winter. Mice also may migrate into the orchard. Inspect the orchard at intervals during the winter for signs of mouse activity, such as trails and burrows in the snow and evidence of feeding. If signs are found, use grain bait and spot-bait by hand.

Ground Sprays for Meadow Mouse Control

In recent years, organic insecticides have been used successfully as ground sprays for the control of orchard mice. Toxaphene has been used in California, Washington, and New York to control meadow mice in some situations. The use of endrin was developed in Virginia as an efficient ground spray, particularly for the control of pine mice in orchards. Endrin has since been used in other states to control both meadow and pine mice.

Although endrin may control meadow mice as well as pine mice, it presents hazards in use because of its extreme toxicity. Costs are much higher than those for other effective methods of meadow mouse control. The use of endrin is described in the section on pine mouse control, for which purpose it is most effective.

Numerous experiments with ground sprays of toxaphene in New York State orchards have shown that meadow mice may be controlled effectively if the orchards have a medium to light mowed cover. *Orchards with heavy, matted ground cover are not adapted to the use of toxaphene.*

Air-blast speed sprayers may be used to apply the toxaphene *after harvest.* Modify the sprayer by plugging all except the lowest three or four nozzles or groups of nozzles, on each side. Direct them downward toward the orchard floor to coat the vegetation as completely as possible. Sheet metal baffles will aid in directing the air blast toward the ground.

Use Toxaphene Emulsifiable Concentrate (six pounds of actual toxaphene per gallon) and apply it at the rate of approximately five pounds of actual toxaphene per acre. In practice, add water to 10 gallons of toxaphene concentrate to make a 500-gallon tank of diluted spray. Apply this amount to 12 acres to give the approximate rate per acre. Make one trip through each travelway between the tree rows, and adjust the speed of travel to apply the correct amount per acre. A trial run with plain water will aid in calibration.

The cost for toxaphene applied at the above rate is approximately $3.00 per acre (material only).

It is possible that a spray-rig with a horizontal boom and high pressure (500 pounds or more) may increase penetration in heavy cover, but more toxaphene will be used, increasing costs. *There is good evidence that in heavy, matted, or unmowed cover even greatly increased application rates do not give satisfactory control.*

Precautions: Fish are killed by very small amounts of toxaphene. Do not apply the spray where streams or ponds containing valuable fish may be contaminated directly or by run-off. Children, pets, or livestock should be kept out of sprayed areas for a week or more after spraying. In handling toxaphene, observe all precautions prescribed on the container label.

Other Ways to Control Meadow Mice

Trapping mice is practical only in very small areas. Although repellent coatings may give some protection to tree trunks, they do not protect below ground level where damage is often most critical. Repellents may also give a false

sense of security because their weathering qualities are variable. For these reasons they are not recommended.

Dogs that have developed the habit or been trained to hunt mice and dig out their nests are helpful in reducing mouse numbers, but cannot be expected to control the mice. *Caution*: Keep dogs out of the orchard during fall baiting programs. They may be poisoned by eating sick or dead mice that have taken the bait.

Gassing is not a practical way to control meadow mice. The fact that the burrows and tunnels are so obscure and scattered make it ineffective.

The protection and encouragement of the many natural enemies of mice will aid in solving the mouse problem. Hawks, owls, foxes, skunks, and weasels feed daily on mice.

PINE MICE

Pine mice are a major problem in many orchards south of New York. Their distribution in New York State is limited and somewhat localized, but some orchards in the southeastern part of the State, where the soil is a relatively light loam, have persistent colonies of pine mice.

Pine mice resemble meadow mice in general body form, but are somewhat smaller (four or five inches in total length), have a shorter tail and smoother fur, and are a chestnut brown in color. Note that the length of the tail distinguishes the pine mouse from the meadow mouse. The tail of the pine mouse equals the length of the hind foot from heel to toe. The tail of the meadow mouse is almost twice as long as the hind foot.

Pine mice are burrowing animals that live partly underground in a system of branching tunnels. They emerge through occasional openings in the roofs of the tunnels and forage to some extent on the ground for surface vegetation. Their principal food, however, is roots and bulbs of plants, including roots of orchard trees.

Pine mice produce several litters of young each year, usually from March to November. Litters average about three offspring each. The young are ready to breed in two or three months. Although not so prolific as meadow mice, pine mice probably have a higher survival rate because their underground habits protect them from some enemies.

Damage from pine mice may be hard to detect because it is often underground. Damage is not seasonal, but may continue the year around as the mice cut off the smaller roots of the trees, girdle the larger roots, and eat the dark from the basal area of the trunk. Often the damage is detected only by the unhealthy appearance of the injured trees.

Special Methods for Pine Mouse Control

Because of their underground habits, pine mice are difficult to control, and control by baiting should extend throughout the year. One way of baiting pine mice is to probe for their underground tunnels with a sharp stick or steel rod. When the tunnel is located, make an opening in the roof and drop in some fruit or grain bait, prepared as for meadow mice. Bait any natural openings also. This method is slow but can be speeded up by placing at least three permanent bait stations per tree base. Old wooden box tops, slab wood, tar paper or similar items, placed on the ground under the tree limbs, provide the mice with shelters where they build tunnels, or even nests. A month or more after the shelters have been established, several bait placements should be made under each. Mice quickly find baits in such locations. Distribute baits for pine mice in the spring and fall or more often, if possible.

General orchard practices that discourage meadow mice (clearing tree bases and mowing) also may help control pine mice. Both kinds of mice may be present in the same orchard.

Ground Sprays for Pine Mouse Control

Ground sprays of endrin are often effective in pine mouse control, and have been successful when other methods have failed. Costs are relatively high, but are probably justified by the damage resulting from a heavy infestation.

Spray after harvest

The best time to apply endrin is in the early fall immediately after *all harvest* is completed, for there will be no residue problem. Booms or hand-guns can be used to apply endrin. If the ground is not too rough and the pattern of tree growth permits, a horizontal spray boom is effective. Use an 11-foot boom mounted on the spray-rig, with the outer end supported by a swivel wheel; space the nozzles $4\frac{1}{2}$ inches apart and use number 4 discs; drill a $\frac{1}{8}$-inch hole in the center of the whirl plate to get greater penetration of the ground cover. Use a pump pressure of at least 500 pounds per square inch. This rig sprays an 11-foot strip under the tree limbs. Spray each side of the tree row, but do not spray the travelways between the rows.

If the use of a horizontal boom is not practical in your orchard, you may use a vertical boom instead, if the ground cover is not too heavy. The boom is usually placed at an angle to avoid tree limbs and yet direct the spray at the ground, and is attached to the rear of the sprayer. Using an 11-foot boom, fit it with nine solid-stream nozzles at 14-inch intervals. Use number 7 discs for the two upper nozzles, number 6 discs for the next five nozzles, and number 5 discs for the two lowest nozzles. Penetration may be poor with this type of rig

if the orchard is not mowed, and if heavy mulch or ground cover is present. The speed of coverage will be about 16 acres per day with the horizontal boom and about 23 acres with the vertical boom.

Endrin ground spray also has been applied successfully with a hand-trigger gun. For this method, use a gun adjusted to a solid stream, with a number 5 disc and a pressure of 500 pounds per square inch. Apply the spray in parallel lines about 18 inches apart to the area under the tree limbs only. Skip the areas between trees to conserve material. Spray each side of each tree row.

Use correct concentration and rate of application

Endrin may be used as the emulsifiable concentrate (1.6 pounds of actual endrin per gallon) or as the 75 per cent dry wettable powder. Use three pints of the emulsifiable concentrate per 100 pallons of spray, or four pounds of the wettable powder per 500 gallons of spray.

Apply two pounds per acre of actual endrin. To get this rate when using one of the 11-foot booms, apply 100 gallons of spray along a strip of tree row 670 feet long. Calibrate the sprayer first by a trial run with plain water to estimate the speed of travel necessary to apply 100 gallons to 670 linear feet.

When using a hand gun, apply about 10 gallons of spray to each tree. For the sake of economy, spray only the under-tree area.

Caution: Endrin is a highly toxic material. When working with it use great care and the same precautions that would be observed with parathion or TEPP. Avoid all contact with the skin and do not breathe dust or spray mist. Be especially careful with the concentrate, and wash areas of the skin *immediately* if contact occurs. *Read the container label before starting work.*

Because fish are easily poisoned by very small amounts of endrin in the water, do not apply the material where ponds or streams containing valued fish may be contaminated by spray or run-off.

Keep children, pets, livestock, or poultry out of sprayed areas. It is wise to post the orchard with signs reading, for example: "POISON, sprayed to kill mice. Keep out."

RABBITS

Cottontail rabbits often do serious harm to young orchard trees. They especially may damage young trees in nurseries where fruit stock of high value is concentrated in small areas. Young trees may be extensively debarked and destroyed, or terminal and side shoots may be severely clipped. Mature trees may be damaged by twig clipping of the lower branches during periods of deep snow.

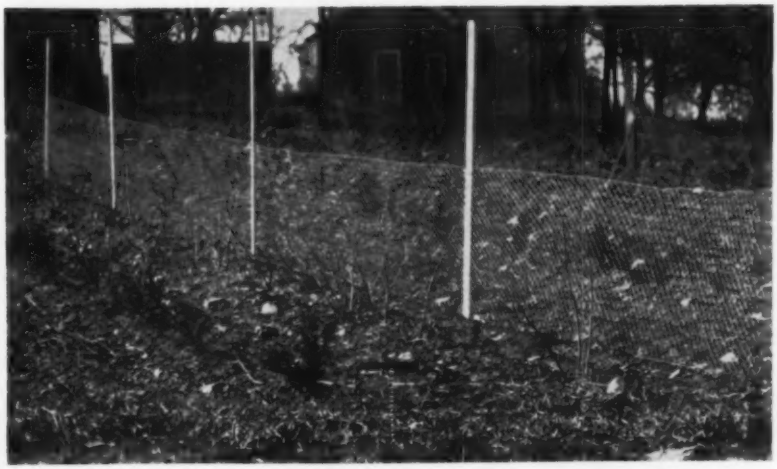
Cottontails are notably more abundant in some years than in others. Several years of relative scarcity may alternate with years of high populations. Adjacent woodlands and brushy fence rows or orchard borders provide suitable habitats for cottontail rabbits. While their summer food consists chiefly of herbaceous and succulent greens, their winter diet is the bark, twigs, and buds of shrubs and trees.

Breeding lasts from early spring to fall, and several litters of four or five young each may be produced in warmly lined nests of grass and fur. These nests are placed in shallow surface hollows among the grass and weeds and are well camouflaged. Young rabbits begin to leave the nest at two weeks of age and gradually acquire independence.

Fencing for Protection from Rabbits

For small areas of high value such as nurseries, fencing may be the most practical method of controlling rabbit damage. Tests have shown that almost complete protection may be provided by fencing at costs that are no greater or even less than the costs of using repellents.

Generally, a two-foot chicken wire fence of one-inch mesh will be adequate to exclude rabbits (see below). In regions where the snow is usually deep in winter, it may be necessary to use a three-foot fence for complete safety. Support the fence with stout stakes and place the lower edge in close contact with the ground. Fill any hollows with earth to remove possible openings. These



Protect small areas from rabbit damage with a simple wire fence.

rabbits will not dig under a fence but will squeeze through existing openings. Attach the fence to the stakes with twists of soft wire for easy removal. If the fence is put up in the fall and removed and stored in a dry place in the spring, it may last from five to 10 years. This is important in reducing costs.

Initial fencing costs average $60 to $70 an acre, but this can be pro-rated over a period of five to 10 years, and the cost per acre is $10 or less per year. Repellents cost approximately the same but do not offer as good protection.

Fencing is not practical for orchards because the areas usually are too large. Young trees may be individually protected by cylindrical chickenwire guards, or by wrappings of aluminum foil, but it is usually more practical to use a repellent on large numbers of young orchard trees.

Reduce Damage with Repellents

A good rabbit repellent must not only repel rabbits, but must have lasting or adhesive qualities for one application to provide protection for the entire dormant season. One of the best and cheapest preparations used to eliminate cottontail rabbits is a rosin-alcohol mixture that may be prepared by the grower.

Rosin-alcohol repellent

Dissolve seven pounds of tree rosin in one gallon of denatured alcohol. Allow to stand in a warm place for 24 hours and stir occasionally to dissolve the rosin. Paint or spray on dry trees in the fall. For spraying, thin the mixture by adding one gallon of denatured alcohol per gallon of stock repellent.

For large numbers of small trees, use a knapsack sprayer to save the labor of hand-painting. Trees less than five years old may be treated at costs of less than five cents per tree, if only the lower trunk and limbs that a rabbit can reach are coated, taking possible depth of snow into consideration. One gallon of repellent will coat about 100 five-year-old trees or 200 to 300 two- or three-year-old trees.

Several commercial preparations containing rosin meet the requirements for a good cottontail repellent.

Thiram repellent mixtures

Thiram (tetramethylthiuram disulfide) is a fungicide that has shown good animal repellent qualities in some preparations. One mixture effective for New York State conditions uses asphalt water emulsion as a carrier and sticker. To prepare, add two pounds of Tersan 75, or two quarts of Arasan 42-S (both contain thiram), to a mixture of one gallon of asphalt water emulsion and one gallon of water. This black-colored mixture is difficult to spray but is easily painted on the trees.

A light-colored mixture of thiram may be prepared as follows: Add two pounds of Tersan 75, or two quarts of Arasan 42-S to one gallon of water. Add two quarts of Rhoplex AC-33, or Latex 512R, as an adhesive. This mixture may be painted, or it may be sprayed with a nozzle having a 0.5-millimeter or larger orifice. Use a 50-mesh strainer.

Commercial preparations containing thiram are now marketed as rabbit and deer repellents. These have good adhesive qualities.

Nicotine sulfate repellent

Add one quart of commercial 40 percent nicotine sulfate preparation to a mixture of one gallon of asphalt water emulsion, 1½ gallons of water, and one pound of household detergent. This may be painted full strength, or diluted for spraying by adding one gallon of water and one pint of nicotine sulfate. This black-colored mixture may be difficult to spray. Follow the above recommendations for nozzle size and strainer mesh.

DEER

Orchards may be damaged by deer during the fall and winter months, and orchards located near large deer populations also may be injured during the growing season. If an orchard lies between two favored feeding or shelter areas, damage is particularly persistent because the deer feed daily in the orchard as they move from one area to the other.

Deer injure orchard trees by browsing on the buds and terminal twigs of both young or mature trees. Young trees may become grossly stunted or missshaped, and useless for future production. Older trees may have their shape altered and production greatly lowered. In late summer or early fall, young trees may be destroyed by buck deer as they rub and thrash them with their antlers.

Deer are now abundant in many agricultural areas. When the damage they do becomes extensive and serious, the solution is essentially in adjustment of deer numbers in relation to the carrying capacity of the area. This is regulated by game laws administered by the State Conservation Department.

Fences and repellents may be used to reduce damage from deer, but high costs and other factors complicate their extensive use in commercial orchards.

Fences

A wire-mesh fence, eight feet high on stout posts, will exclude deer. The cost to enclose a 50-acre area may be $2000 or more, but the fence will last more than 10 years if properly maintained. The pro-rated cost would then be $200 a year, plus maintenance.

Because orchards are often irregularly shaped, traversed by roads, and may have many points of access, fences often are not practical.

Electric fences have been designed especially to exclude deer. Although generally less expensive than a wire-mesh fence they are also less reliable. They must be constantly maintained and serviced. Some causes of failure are shorting of the electric current by weeds, brush, or deep snow, and current leakage from poor insulators. If snow accumulates to depths of two feet or more, failure is common. If the deer are unusually plentiful, they often learn to jump the fence or sometimes may break through when chased by dogs or hunters. For a 50-acre plot the cost of a permanent electric fence to exclude deer is between $200 to $300 for materials only, *excluding posts* and labor.

Specifications for deer fences may be obtained from the Department of Conservation, New York State College of Agriculture, Ithaca, New York.

Repellents

In addition to chemical repellents, numerous devices such as noise makers and lights have been tested to repel deer. None of these has been more than temporarily usable, for the deer soon become accustomed to them and learn to ignore them.

Several chemical mixtures that will reduce deer browsing are available for use on vegetation. Some of these are of little value to fruit growers because they have limited lasting qualities under New York State weather conditions. Others with good weathering qualities may be too costly to apply extensively to mature orchard trees, although they are economical and useful for the protection of young trees.

Thiram

A repellent formula containing thiram (tetramethylthiuram disulfide) has been developed by the United States Fish and Wildlife Service for use against deer. This is a taste repellent, and deer must sample the vegetation to be repelled. It has good weathering qualities when properly prepared and applied to dormant trees. Under growing conditions, the need for frequent respraying to protect the new growth is costly and limits its usefulness.

Because of the difficulties involved in obtaining some of the ingredients in the formula and the complicated methods of preparation, it is not practical for an individual grower to prepare the mixture. Several commercial products (made according to specifications for this repellent supplied by the United States Fish and Wildlife Service) are marketed.

ZIP

A deer-repellent mixture containing zinc dithiocarbamate-amine complex is marketed commercially. A similar mixture was hailed more than a decade ago as the first effective deer repellent, but subsequent experience indicated limited

weathering qualities under dormant conditions. The latest formulation of ZIP has greatly improved adhesive qualities and a wider range of use. As with thiram repellents, costs may limit the extent of use of this repellent.

Other repellents

A great variety of chemicals, compounds, and mixtures have been advocated as deer repellents. Most of these have been of little or no use in practice. Repellents containing bone tar oils have a limited usefulness because of poor weathering qualities and an odor that is strong and repulsive to humans. Repellents containing nicotine compounds and distillation products have had limited use because of weathering qualities and general lack of effectiveness under extreme deer pressure.

Applying repellents

To protect the dormant orchard, where damage occurs under winter conditions, spray the trees as late in the fall as weather and ground conditions will permit. Repellents should be applied in non-freezing, dry weather. Power or hand sprayers may be used. Spray only outer portions of the twigs on mature trees to a height of seven feet to conserve material. Use only moderate spray pressure; a penetrating spray is not needed. Coat very young trees completely. Follow the manufacturer's recommendations for dormant season spray dilutions.

Deer damage to orchard trees during the growing season is usually limited to special areas of extreme deer pressure. Because of new growth, even the most weather-resistant repellents must be applied at repeated intervals if damage persists. Growing season sprays are made at much greater dilutions than those for the dormant seasons. Follow the maker's instructions.

Costs

Costs for the application of successful repellents on a commercial basis are high. Field tests (1959) indicated that the average cost of materials for one application to 13-year old apple trees was more than $2.00 per tree, at dormant-season dilutions of 1:4. Three-year-old trees were sprayed at an average cost of about 30 cents per tree for materials. For a producing orchard, cost of repellent material alone might be more than $50 an acre for dormant trees.

An Extension Publication of the New York State College of Agriculture, a unit of the State University, at Cornell University, Ithaca, New York